Helios Mission Support

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This article reports on activities of the Network Operations organization in support of the Helios Project from 15 October 1977 through 15 December 1977.

I. Introduction

This article is the nineteenth in a continuing series of reports that discuss Deep Space Network support of Helios Mission Operations. Included in this article is information on Mark III Data Subsystem (MDS) testing at the conjoint Deep Space Stations (DSS) 42/43 (Canberra, Australia); MDS implementation at DSS 61/63 (Madrid, Spain), Radio Science update, and other mission-related activities.

II. Mission Operations and Status

The Helios 1 spacecraft sixth perihelion occurred on 21 October 1977 at 02:20 UTC over DSS 43 (Australia). This was 1045 days, 19 hours, 09 minutes and 30 seconds after launch. The spacecraft telemetry data rate was 1024 bits per second, and the round-trip light time was 20 minutes, 14 seconds. The spacecraft was configured with TWTA 2, at medium power using high-gain antenna, with all science experiments operating. All systems and experiments performed nominally.

The Helios 2 spacecraft fourth perihelion occurred on 26 October 1977 at 08:34 UTC, also over DSS 43. This was 650 days and 3 hours after launch. The spacecraft round-trip light time was 17 minutes, 56.2 seconds, and the telemetry data rate was 2048 bits per second. The spacecraft configuration was TWTA 1 at medium power using high-gain antenna, and all science experiments operating. All spacecraft subsystems and experiments performed nominally.

One anomaly did occur right at perihelion for Helios 2. The temperature of the spin thruster assembly increased very rapidly, culminating on 27 October 1977 at 1200 GMT at a temperature of 205.0 deg Celsius. The calculated temperature measurement stub "X" (D-111) also increased in the same way, reaching 181.6 deg Celsius at the same time. During the earlier testing phase of the thruster units, a leakage occurred on a model that was cooled down from about 200 deg Celsius. It was suspected that this might recur during the coming aphelion phase; therefore, a decision was made to dump excess gas before possible uncontrolled spin-rate changes could take place.

The gas-dumping maneuver was performed 12 December 1977. The maneuver was performed in ten single steps.

Step 1	16 pulse precession maneuver to verify technical capability and exclude unsymmetrical forces.
Step 2	256 pulse precession maneuver.
Step 3	512 pulse precession maneuver. Spacecraft shows a slight nutation of 3 data numbers

	(DN) between 0.4612 and 0.5151-deg sun sensor angle.
Step 4 to 7	512 pulse precession maneuvers. No change in nutation. Increased spacecraft spin-rate by one DN from 60.952 to 61.012 rpm.
Step 8	328 pulse precession maneuvers, leaving a gas mass of approximately 0.25 kg.
Step 9	16 pulse spin-down maneuver, spin-rate to 60.591 rpm.
Step 10	4 pulse spin-down maneuver; spin-rate is now 60.472 rpm.

All steps using the precession nozzle were carried out as combined roll positive/roll negative maneuvers to eliminate the resulting forces and to avoid attitude changes.

The maneuver occurred over DSS 11 and DSS 12 with a round-trip light time ranging from 3 minutes, 0.43 seconds to 2 minutes, 59 seconds. The spacecraft was programmed to telemetry format 4 (engineering data only) to allow closest control. Following the maneuver, the condition of the attitude system was:

Gas pressure high	7.108 bar
Gas pressure low	3.449 bar
Gas tank temperature	-10.00 deg Celsius
Sun sensor angle	0.4912 deg
Spin rate	60.472 rpm
Gas mass approx.	0.25 kg

The gas saved for later correction (if necessary) allows for a spin-rate change of 3 rpm in either direction. Yet uncontrolled leakage will not jeopardize the mission. Throughout the maneuver, the spacecraft performance was excellent, as was the support from all participants.

Overall coverage of both Helios 1 and Helios 2 for this period is listed in Table 1.

III. Special Activities

A. DSN Mark III Data Subsystem (MDS) Support of Helios:

As reported earlier (Ref. 1) DSS 42/43 began its MDS test and training period on 26 September 1977. During this period, 8 Helios demonstration tracks were conducted with overall success prior to placing the complex in configuration control. DSS 42/43 was placed under configuration control on 18 October 1977.

DSS 61/63 (Madrid, Spain) began MDS implementation on 16 October 1977. The complex is scheduled to begin test and training on the 1st of January 1978. As with other MDS stations, the Helios training will consist of scheduled demonstration tracks to verify proper MDS support of Helios flight operations. The results of this training will be reported in a future article.

B. Support of On-Board and Ground Experiments

In the last article coverage of the Special Traveling Interplanetary Phenomena (STIP), period IV was briefly discussed. This activity involved primarily the alignment of Helios 2 with Voyagers 1 and 2. Figure 1 shows the Voyager and Helios trajectories during this period. The coverage of this alignment is scheduled to end on 31 December 1977. At this writing, no results have been released, but hopefully some data will be available in the near future.

On 7 December 1977 a pitch maneuver was performed on Helios 2 to provide data for Experiment 9. Experiment 9 is the Zodiacal Light Photometer. From these observations, information is obtained about spatial distribution of interplanetary dust and the size and nature of the dust particles. This experiment provides a completely new and very promising type of scientific information about interplanetary dust and its variation with distance from the Sun. The maneuver was needed for optical alignment and proper data collection.

During the last perihelion periods of Helios 1 and Helios 2 (Ref. 1), a large amount of data was collected in regard to Experiment 12 (Faraday Rotation). It was hoped that by the time of this article some results could be available for this report, but due to the amount of data collected processing is taking longer than originally thought.

It is hoped some substantial results will be available for publication during the next period. However, those readers desiring a comprehensive report on Helios science results will find that the entire issue of Ref. 2 is devoted to that purpose. That issue's editor is H. Porsche, Helios Project Scientist.

References

1. Goodwin, P. S., Burke, E. S., Rockwell, G. M., "Helios Mission Support", in *The Deep Space Network Progress Report 42-42*, Jet Propulsion Laboratory, Pasadena, California, October 15, 1977.

2. *Journal of Geophysics* (Springer International), Vol. 42, No. 6, 1977, pp. 551-742. Edited by H. Porsche.

Table 1. Helios tracking coverage

Month	Spacecraft	Station type	Number of tracks	Tracking time (h, min)
October	Helios 1	26 meter	51	251:11
		64 meter	13	57:05
	Helios 2	26 meter	17	115:54
		64 meter	33	176:41
November	Helios 1	26 meter	46	288:12
		64 meter	10	60:12
	Helios 2	26 meter	40	368:32
		64 meter	18	119:25

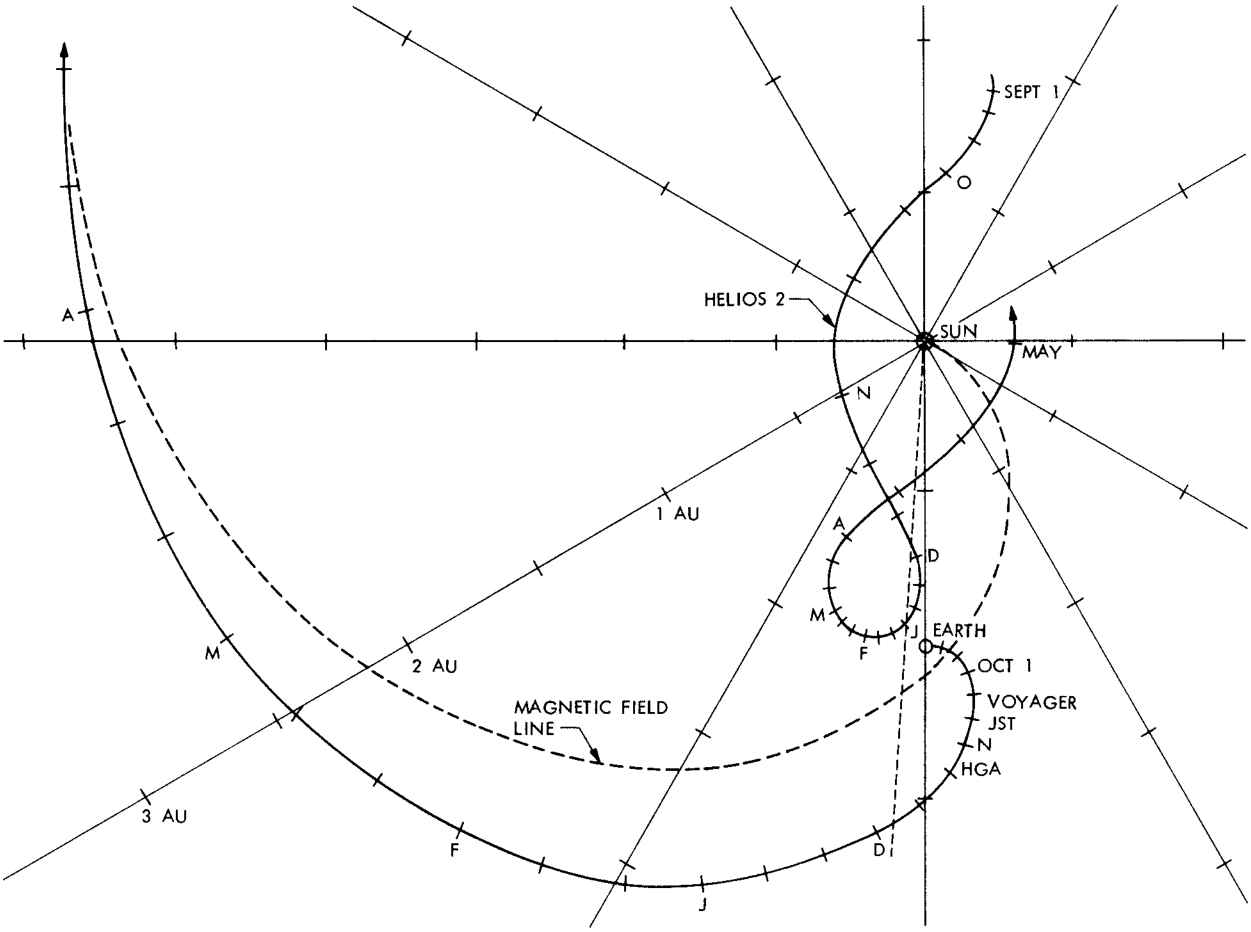

Fig. 1. Voyager and Helios trajectories (fixed Earth-Sun line plot)